

Comparison of two non-radiographic techniques of mixed dentition space analysis and evaluation of their reliability for Bengali population

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Abstract

Context: Mixed dentition arch analysis system is an important criterion in determining the type of orthodontic treatment plan. Different mixed dentition arch analysis system are available and among them both Moyer's and Tanaka-Jhonson method of space analysis was developed for North American children. Anthropological study reveals that tooth size varies among different ethnicities. The present study was performed to determine the reliability of Moyer's and Tanaka-Jhonson's method of mixed dentition arch analysis system among Bengali population. **Aims:** To perform the comparative evaluation of the two mixed dentition space analysis system among Bengali population. **Materials and Methods:** Dental casts of maxillary and mandibular arches of 70 Bengali children with permanent dentitions were fabricated. The mesiodistal crown dimensions of all erupted permanent incisors, canines, and premolars were measured with digital callipers. For particular sum of mandibular incisors, Moyer's and Tanaka-Jhonson's mixed dentition arch analysis were calculated and further statistical analysis was carried on. **Statistical analysis used:** Descriptive statistics including the mean, standard deviation, and minimum and maximum values, unpaired 't' tests, correlation coefficient "r" were calculated and tabulated. **Results:** Tanaka and Johnston regression equations under-estimated the mesiodistal widths of permanent canines and premolars. On the other hand, there were no statistically significant differences between actual mesiodistal widths of canines and premolars and the predicted widths from Moyers charts at the 50% level for the lower and upper arches, among Bengali population. **Conclusions:** The study suggested that both Moyer's and Tanaka-Jhonson's mixed dentition arch analysis are applicable in Bengali population but with little modification in their regression equation.

Key Words: Bengali, Mixed dentition arch analysis, and Moyer's, Tanaka Johnson

Introduction

Pedodontists have a great opportunity to come across patients in their developing stage of life. Malocclusion is one of the major problems faced during dento-facial development. Early intervention of this problem can be done by a proper space assessment in mixed dentition phase.^[1] Mixed dentition arch analysis is an important criterion in determining whether the orthodontic treatment plan is going to involve serial extraction, guidance of eruption, space maintenance, space regaining or just periodic observation of the patient. The determination of tooth size - arch length discrepancy in the mixed dentition requires an accurate prediction of the mesiodistal width of the unerupted permanent teeth. Several

methods have been developed for estimating the mesiodistal widths of unerupted teeth.^[2]

Space analysis in mixed dentition can be grouped into three categories, those that use regression equations, radiographs, or a combination of both methods. Moyers 1958 and Tanaka Johnson 1974 method which uses regression equation to calculate the mesio-distal width of erupted teeth, Nance 1947, Bull 1959 and Huckaba 1964 method which uses measurement of the unerupted teeth on the radiograph and Hixon and Oldfather 1958, Staley and Karber 1980 method which uses combination of above two technique.^[3-6] Of all the mixed-dentition analysis, the regression equations based on already erupted permanent teeth are used most widely, especially the Moyers probability charts and Tanaka-Johnston equations.^[7]

The mixed dentition analysis developed by Moyers utilized the sum of the mandibular permanent incisors as the independent variable. At the 50% level this analysis tended to be optimistic. But at the 80% level, the number of over-estimations was balanced by the number of under-estimations. Moyers considered this level to be superior to that of other mixed dentition analyses tested.^[4]

Recently, a simplified analysis has been proposed by Tanaka and Johnston. They found by linear regression that the mesiodistal width of the permanent mandibular canine and premolars could be predicted at the 75% confidence interval by adding 10.5 mm to half the width of the mandibular incisors. Their results closely matched Moyers' 75% level.^[6]

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Both Moyer's and Tanaka-Johnson method of space analysis was developed for North American children. It is reasonable to question its use in other populations because tooth size varies among ethnicities. This is the major reason behind the comparison of reliability of the two methods among Bengali population in the present study.

Aim

To perform the comparative evaluation of the two mixed dentition space analysis systems among Bengali population for mixed dentition arch analysis.

Objectives

To determine a comparatively more effective and more reliable method of mixed dentition space analysis system among Bengali population, which can be used for orthodontic diagnosis and treatment planning.

Materials and Methods

Dental casts of maxillary and mandibular arches of 70 Bengali children (36 females, 34 males; age range, 11 to 14 years) with permanent dentitions (with the exception of second and third molars) were fabricated from the patients randomly selected from the out-patient Department of Pedodontics and Preventive dentistry, Gurunank Institute of Dental Science and Research, West Bengal.

The criteria for selection were based on the following:

- Patients had to be resident of Bengal.
- The dental casts had to be of high quality.
- The teeth measured had to be free of malformations, restorations, absence of any previous orthodontic treatment, fractures, or caries as determined by radiographic examination.
- All permanent teeth with the exception of second and third molars) should be present and fully erupted in the mandibular arch.

Many authors have adopted these criteria.

The mesiodistal crown dimensions of all erupted permanent incisors, canines, and premolars were measured with digital callipers. The callipers were held parallel to the occlusal surface and perpendicular to the long axes against the contact points of the respective teeth. The electronic digital had an accuracy of ± 0.01 mm. To better adjust for the interdental spaces, the calliper tips were ground until they were pointed. All manual measurements were recorded to the nearest 0.01 mm after initial calibration.

For particular sum of mandibular incisors, Moyers chart was used to find out percentage level at which the measured sum width of mandibular canine and premolars falls. The values

were also calculated by using Moyers's probability chart at 75% level as suggested by Moyers, for given sum of mandibular incisors. Mesiodistal diameter of unerupted mandibular canine and first and second premolars were also calculated according to Tanaka – Johnson's approach by adding 10.5 mm to half the total width of the mandibular four incisors. The results were subjected to statistical analysis.

The statistical analysis performed are (1) Descriptive statistics including the mean, standard deviation, and minimum and maximum values were calculated for the predictive tooth size as well as actual tooth size. (2) Unpaired 't' tests were used to determine whether significant differences were present in the mesiodistal tooth size on right and left side and between the predicted and actual tooth size obtained by both the prediction methods. (3) Correlation coefficient "r" was performed between the sum of mandibular canine, first premolar and second premolar and the sum of four mandibular incisors obtained by both the prediction methods.

Results

Means, standard deviations, range, and standard error of the means for the sum of four lower mandibular incisors, sum of the lower canine and premolars, and the sum of the maxillary canine and premolars for the sexes combined were tabulated.

Comparisons of actual tooth sizes between right and left sides

No significant differences were present in teeth in right and left side, where P value ranged from $P = 0.587$ to 0.677 showing greater amount of similarity in size of both side.

Male and Female comparisons

Preliminary analysis indicated that predictive differences between the sexes were statistically not significant for both the prediction methods. So the prediction equations for Bengali population were not calculated separately for males and females.

Differences between the actual and predicted tooth size

The findings indicated that the differences between the predicted width of the canine and premolars by Tanaka Johnston and Moyers method and actual widths were highly significant in the statistical sense, as indicated by t tests. Tanaka Johnson approach overestimated the tooth size of the unerupted canine and premolars for the mandibular arch. The difference of Mean and standard deviation for both actual and predicted. The T-Value = -3.99 P -Value = 0.000 was observed. Figure 1 shows the comparison between actual and predicted value determined through Tanaka-Johnson's approach, in respect to mean and standard deviation.

Moyers probability at 75% level also over estimated the tooth size of the unerupted canine and premolars for the mandibular arch. The difference of Mean and standard

deviation for both actual and predicted. The T-Value = -3.49 P-Value = 0.001 was observed. Figure 2 shows the comparison between actual and predicted value determined through Moyers's approach, in respect to mean and standard deviation.

Scatterplot Graph with regression for both prediction methods were fabricated, Figure 3 and Figure 4 shows scatterplot graph for Tanaka-Johnson's and Moyers's prediction value respectively. Moyers probability at 50% level, Moyers probability at 65% level, Moyers probability at 85% level were tabulated which showed a T-Value = 1.14 P-Value = 0.257, T-Value = -0.73 P-Value = 0.468, T-Value = -4.03 P-Value = 0.000 respectively.

Correlation coefficient (r) and Regression equation were also formulated

Pearson correlation "r" of sum of mandibular incisors and actual sum of canines and premolar in lower arch = 0.611, and in upper arch = 0.591

By using the above data, regression equations were formulated, separately in both arches,

As $Y = 9.5 + .488(X)$ for lower arch,

$Y = 10.3 + .493(X)$ for upper arch

Where, $Y = a + b(X)$

{X = independent variable (mandibular incisors measurements)

Y = dependent variable (sum of canine and premolars).}

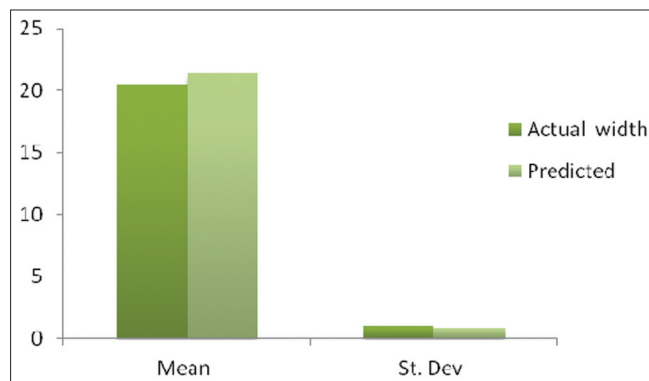


Figure 1: Comparison between actual and predicted value determined through Tanaka-Johnson's approach

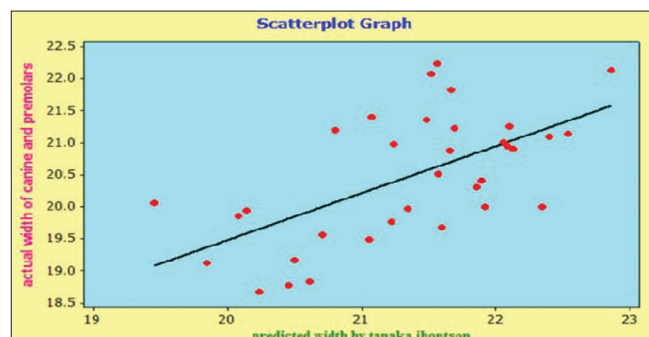


Figure 3: Scatterplot graph for Tanaka-Johnson's approach

Discussion

The history of mixed dentition space analysis is date back from 1897 when Black (1897) determined the average mesiodistal crown widths of all primary and permanent teeth. Siepel (1946) published the first method of predicting the widths of canines and premolars.^[8]

Ballard and Wylie (1947) developed a prediction method by correlating the sum of mesio-distal widths of the four mandibular incisors with the combined widths of mandibular canine and premolars on one side of the arch. The correlation coefficient was found to be moderately positive ($r = 0.64$).^[9] Moorress (1959) investigated measurements on dental casts of 184 North American children of European ancestry. He found sex difference, males having larger teeth than females; the permanent incisor and canines were larger than their predecessors, whereas premolar teeth were smaller. He concluded that measurement of unerupted permanent canines and premolars on radiographs was more accurate than estimation by measurement of the primary dentition.^[10]

Singh and Nanda (1972) discovered that the values for the Indian children were very different from those of Caucasian children, from which they concluded that there were racial discrepancies in tooth size and therefore data collected from one ethnic group were not transferable to the other.^[11]

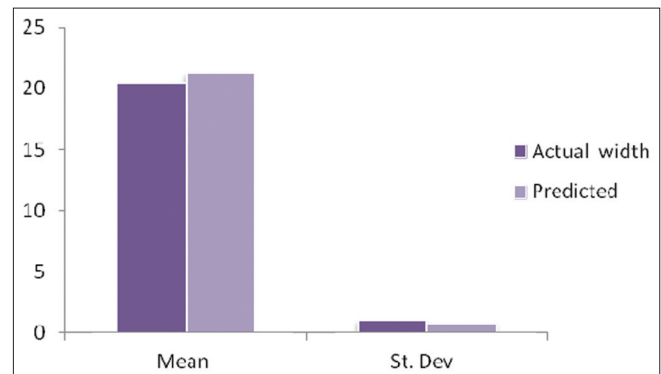


Figure 2: Comparison between actual and predicted value determined through Moyers's approach

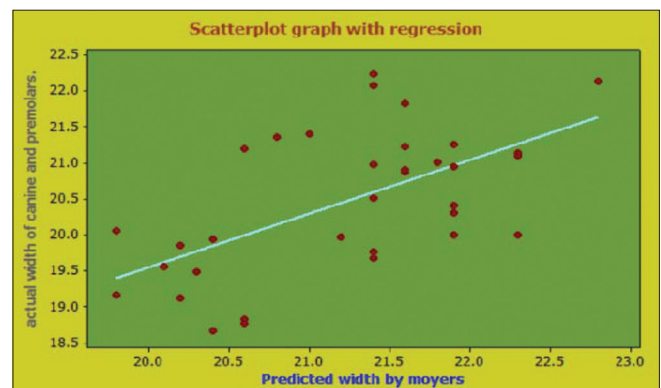


Figure 4: Scatterplot graph for Moyers's approach

The size of the teeth is related to genetics (e.g., gender and ethnicity) and environment. Racial and gender-specific mixed dentition space analysis requires revision or validation once every generation (approximately 30 years) because of changing trends in malocclusion and tooth size. Through the years, proposed polymorphisms based on ethnicity, sex, side of mouth and jaw have been the basis of numerous articles about new or updated Mixed Dentition Space Analysis approaches.

In followings year many more analysis techniques where developed on the basis of three criteria namely, based on regression equation, radiograph and combination. The common ones using simple regression equations are Tanaka and Johnston (1974) Moyers (1976). Nance (1947) first suggested the use of periapical radiograph measurements for prediction of the widths of unerupted teeth.^[4,5] At the present time, Nance arch analysis is seldom used, partly because it requires a complete set of periapical radiographs. Foster and Wylie (1958) Cohen (1959) Sim (1972) also worked on space analysis technique using radiograph. Hixon and Oldfather (1958) Bull (1959) Stahle (1959) Ingervall and Lennartson (1978) used the combination of regression and radiograph.^[12-14, 15]

Studies comparing different methods of mixed dentition analysis were done time to time. Zilberman *et al.* (1977) Kaplan *et al.* (1978) Gardner (1979) Staley and Hoag (1978) were few of them who compared many mixed dentation analysis to find their reliability on different population.^[1 6-18]

The sole purpose of our study was to compare two non radiographic mixed dentition prediction methods, Tanaka Johnston and Moyers, and to evaluate their applicability to Bengali population.

From this study following results were approached- (a) Two non radiographic methods for predicting mesiodistal diameter of the unerupted canine and premolars, Tanaka Johnston and Moyers, have comparable standard errors of estimate, therefore accuracy of both the prediction methods is fairly comparable and any one of these methods can be used according to convenience. (b) Both the prediction methods over estimated the actual tooth size of unerupted canine and premolars in Bengali population, therefore both prediction methods would not be as accurate in this population. (c) Moyers chart at 65% confidence level gives more realistic estimate of width of unerupted canine and premolars as compared to 75% confidence level for Bengali population. (d) To get more precise results in Bengali population, instead of using Tanaka Johnston prediction equations, the use of newly developed regression equations is suggested, which are $As Y = 9.5 + .488 (X)$ for lower arch, $Y = 10.3 + .493(X)$ for upper arch.

Two studies were done similar to our study, one in Maharastrian population in, India, and other in Jordanian population, in Jordan in the year 2008 and 2006 respectively.

In Indian study, they found Moyers chart at 50% confidence level gives more realistic estimate of width of unerupted canine and premolars as compared to, 75% confidence level for Marathi population. And for Tanaka Johnston prediction equations, the use of newly developed regression equations is suggested which is

For mandibular teeth, $Y = 10.830 + 0.563 (X)$

For maxillary teeth, $Y = 12.143 + 0.481 (X)$ ^[7]

For Jordanian population they found except for the maxillary arch in male subjects, Tanaka and Johnston regression equations underestimated the mesiodistal widths of permanent canines and premolars. On the other hand, there were no statistically significant differences between actual mesiodistal widths of canines and premolars and the predicted widths from Moyers charts at the 65% and 75% level for the lower and upper arches in male subjects and at the 85% level for the upper and lower arches in female subjects.^[1]

So to conclude, this study suggested that both Moyer's and Tanaka-Jhonson's mixed dentition arch analysis are applicable in Bengali population but with little modification in their regression equation.

Further study has to be performed on a larger population and for a longer duration of time to get a more accurate result.

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